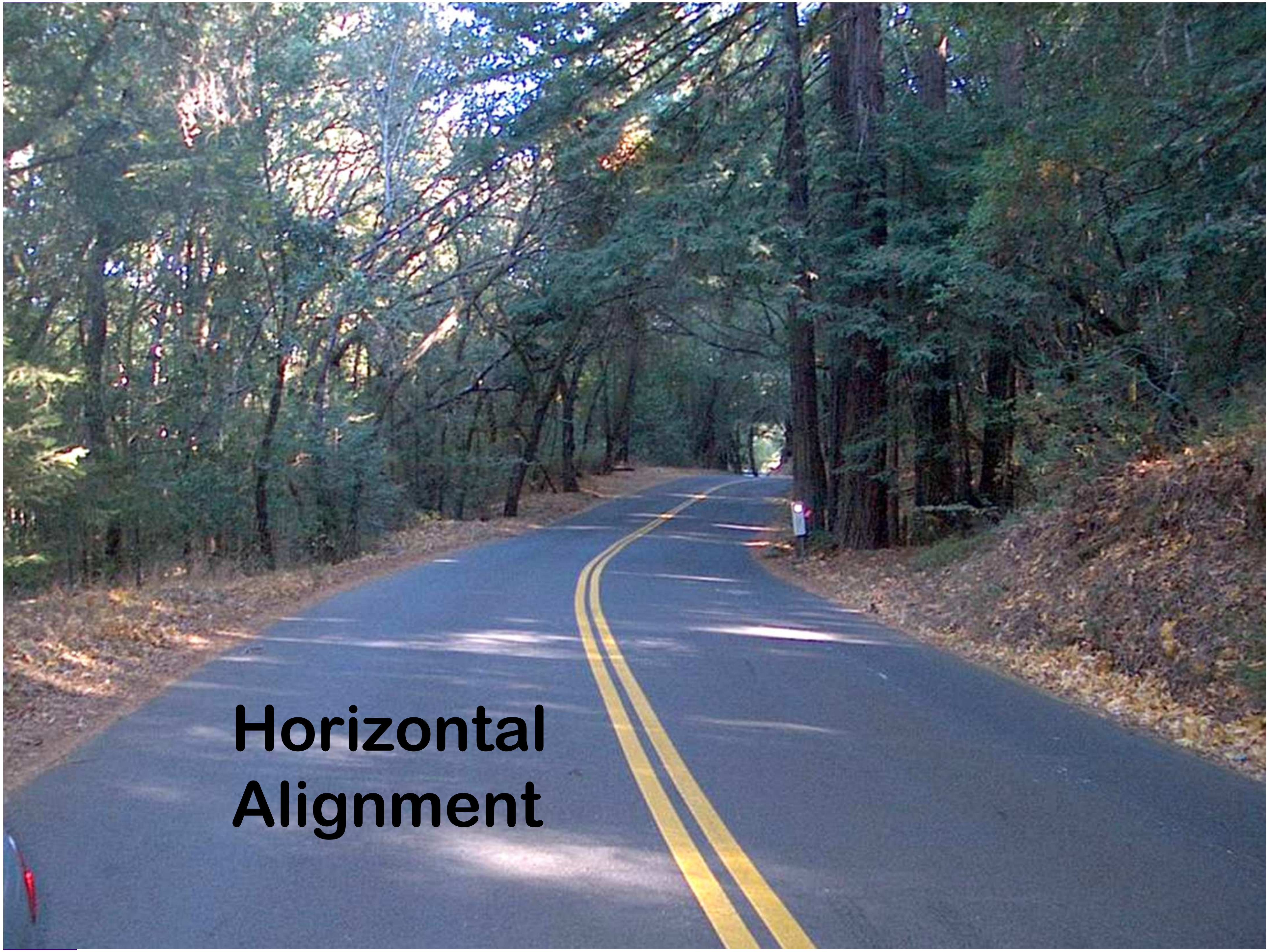
Horizontal
Alignment

2. Sight Distance (Side Obstruction)

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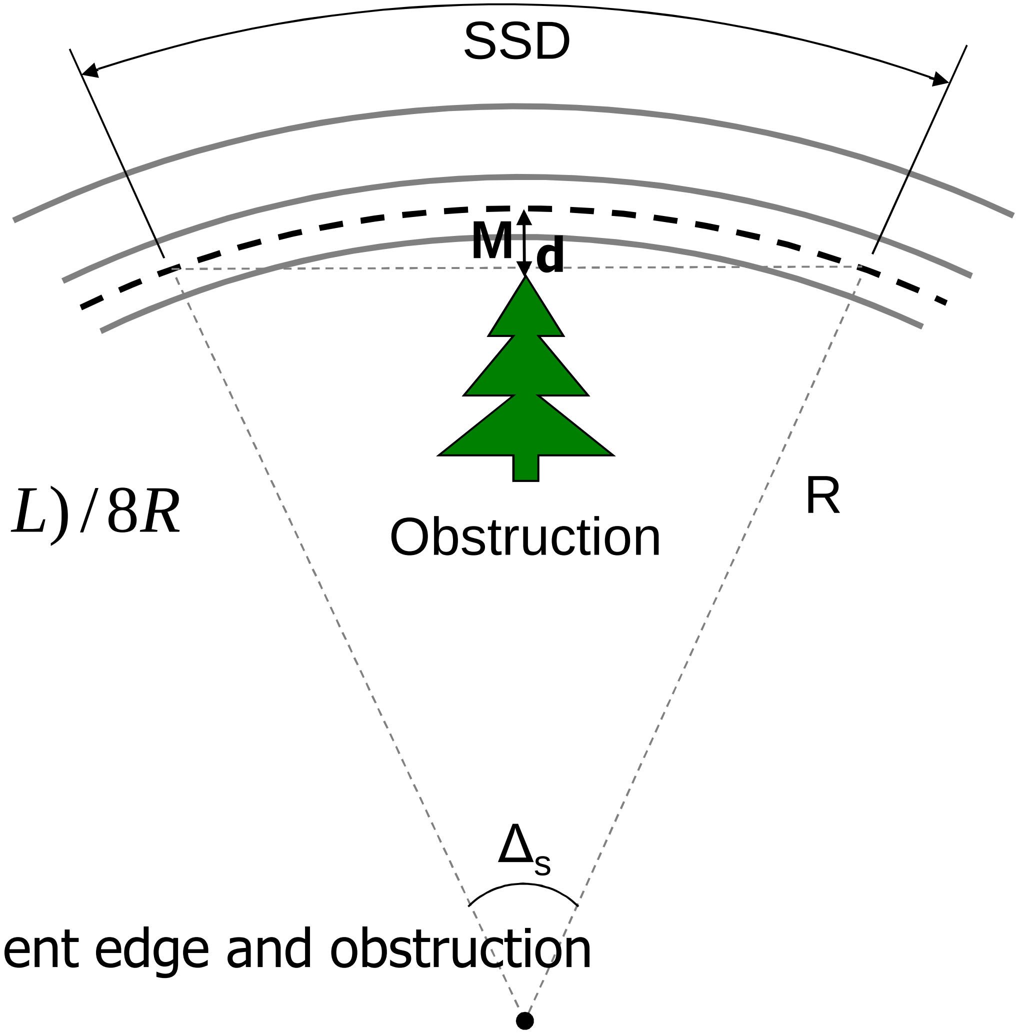
Sight Distance



at S < L $\quad M = S^2/8$

at S > L $\quad M_s = L(2S - L)/8R$

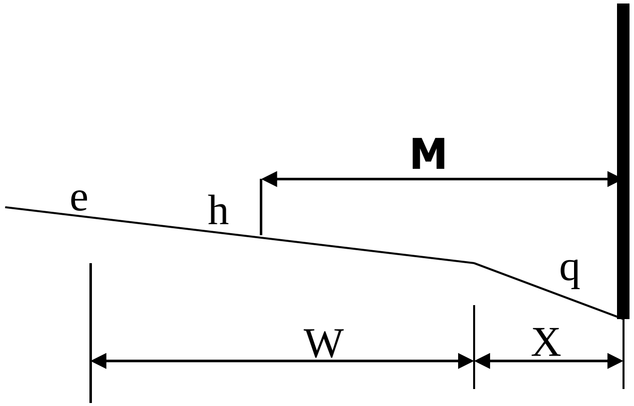
M = W/2 + X + d

W: lane width

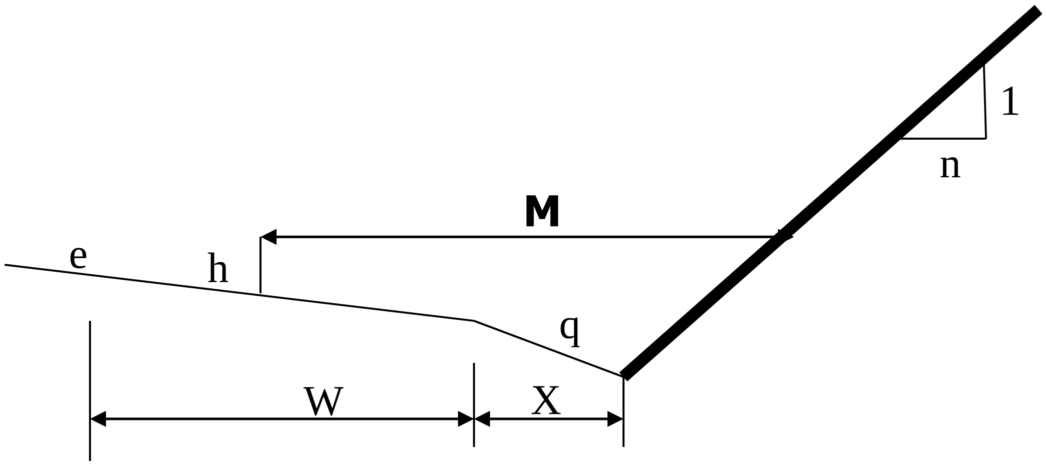
X: Shoulder width

d: distance between pavement edge and obstruction

Sight Distance



$$M = W/2 + X$$

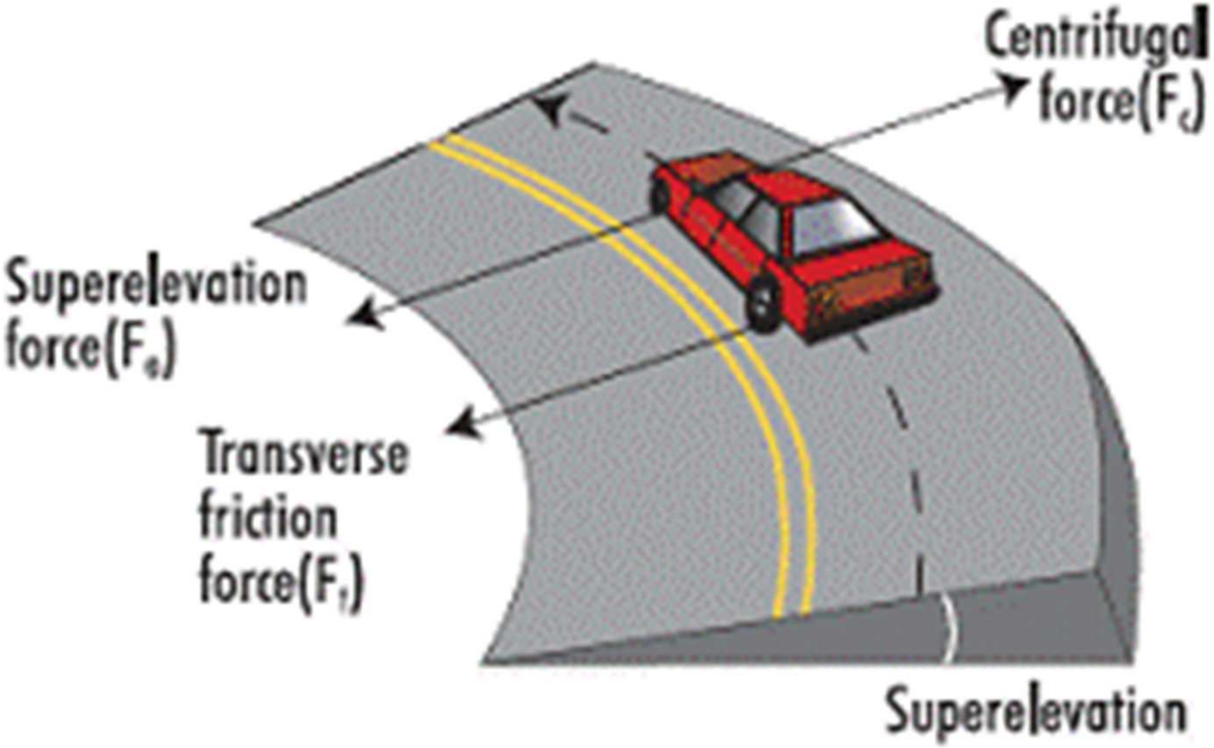


$$M = W/2 + X + n\,(W/2 \times e + X\,q + h)$$

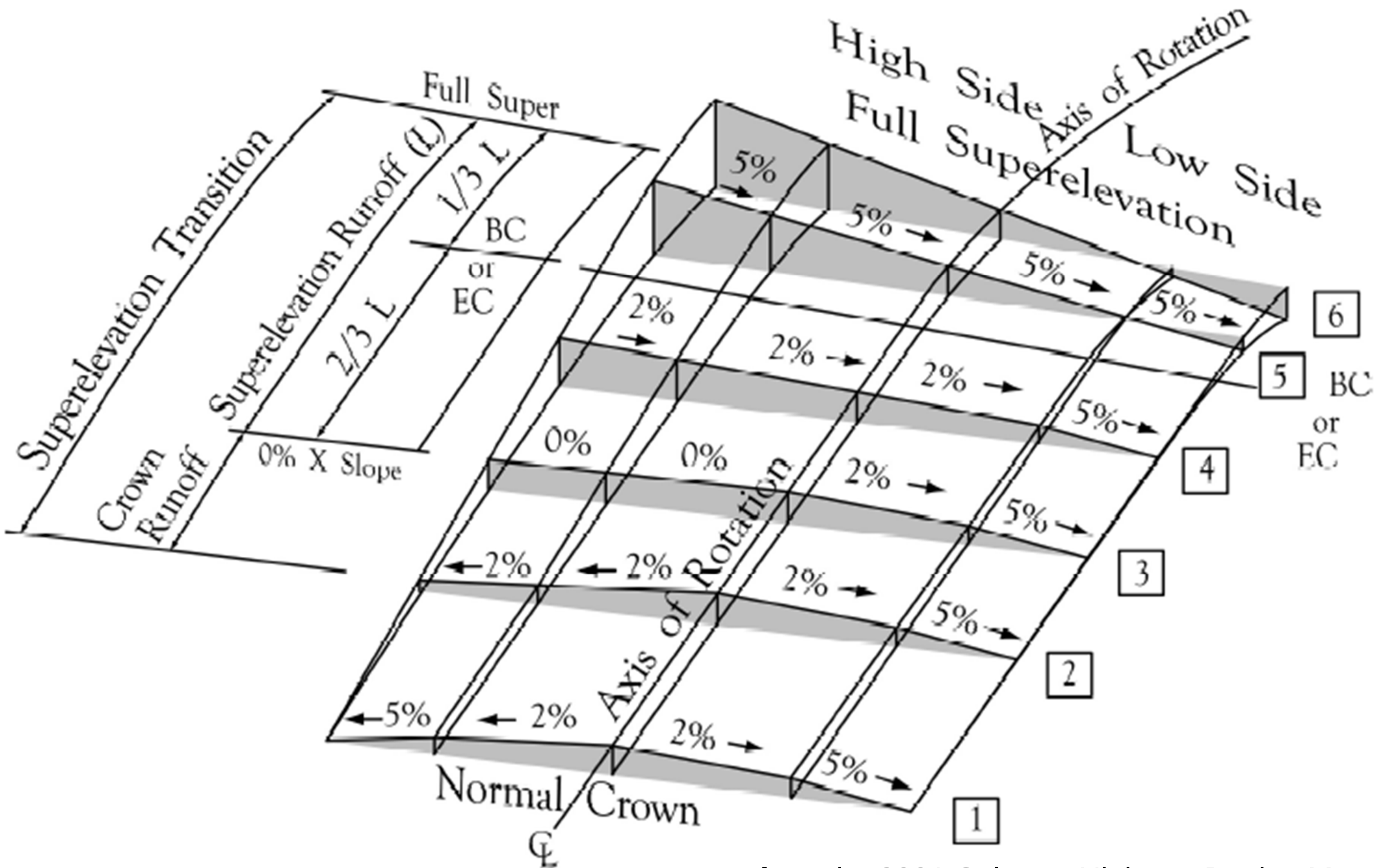
Other Elements

- **Superelevation Transition**
  - **Runoff**
  - **Tangent runout**
- **Spiral curves**
- **Extra width for curves**

Superelevation

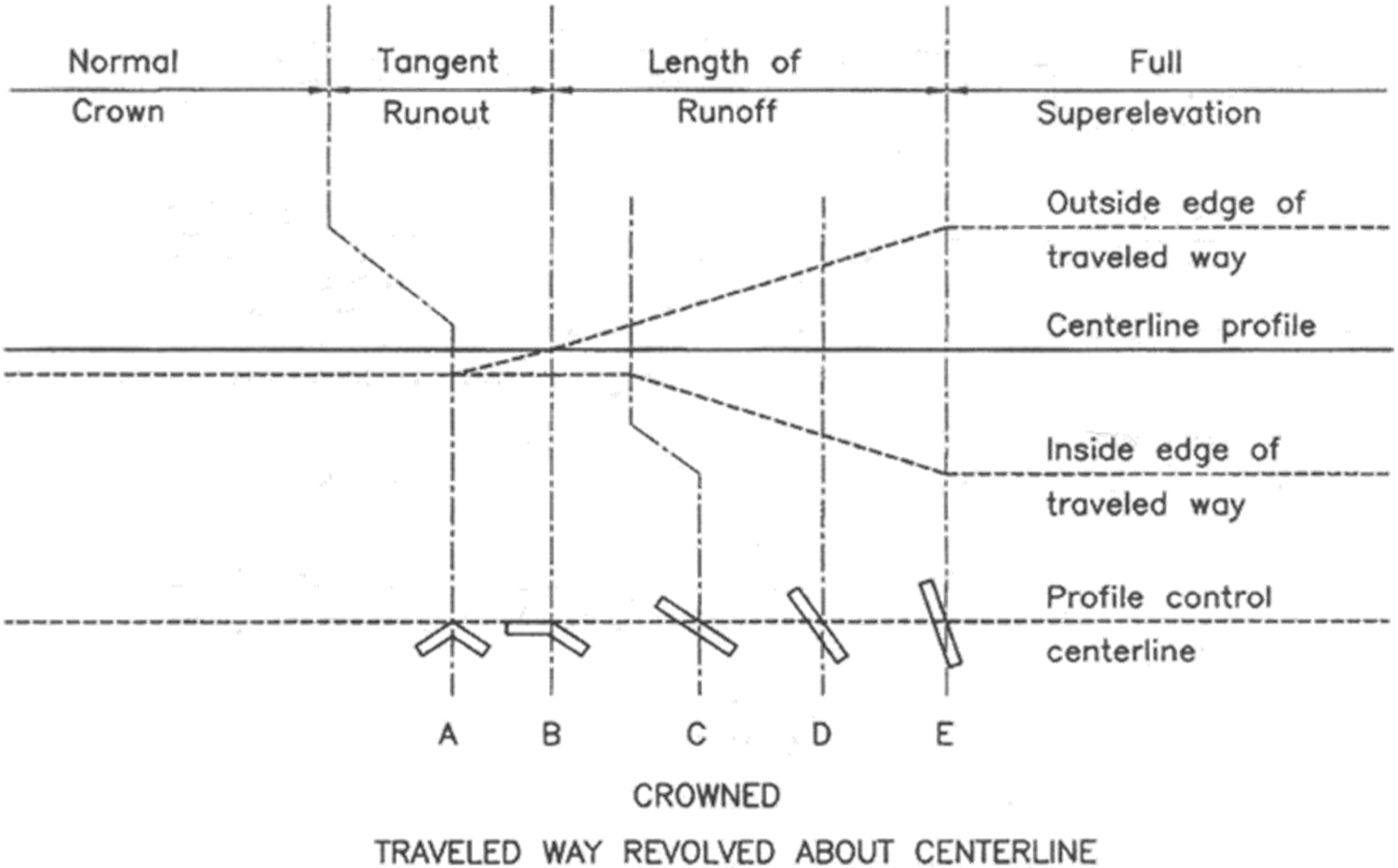


Superelevation Transition



from the 2001 Caltrans *Highway Design Manual*

Superelevation Transition



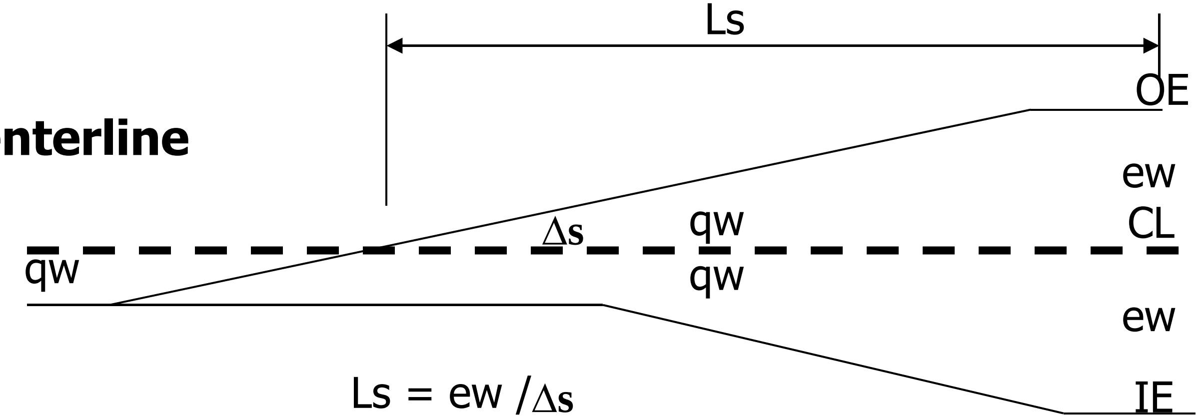
from AASHTO's *2001*

Superelevation Transition for 2way/2lane

There are three basic methods of profile design in attaining

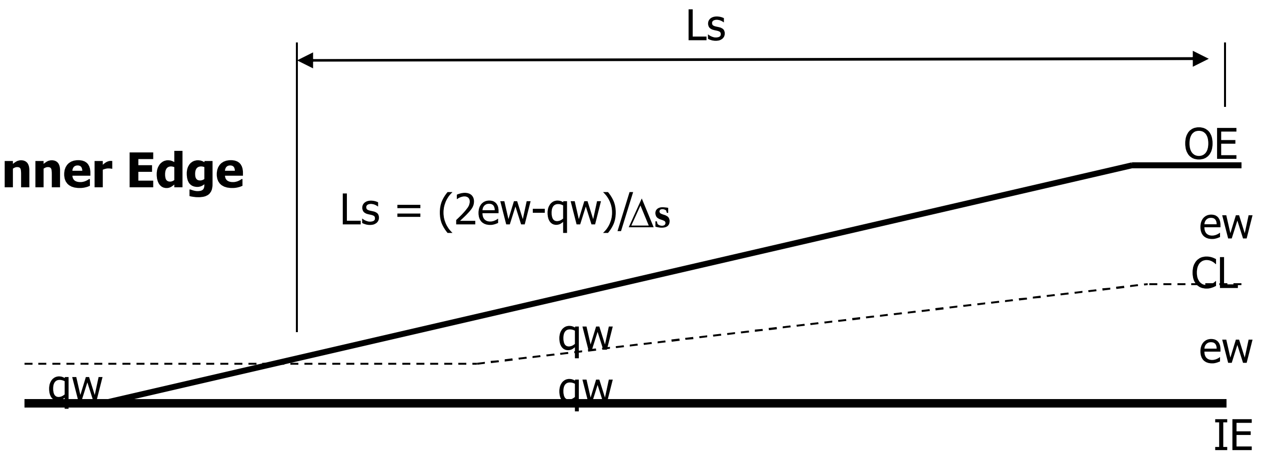
- Revolving about the centerline profile (C.L.).
- Revolving about the inside-edge profile (I.E).
- Revolving about the outside-edge profile (O.E).

Revolving about Centerline

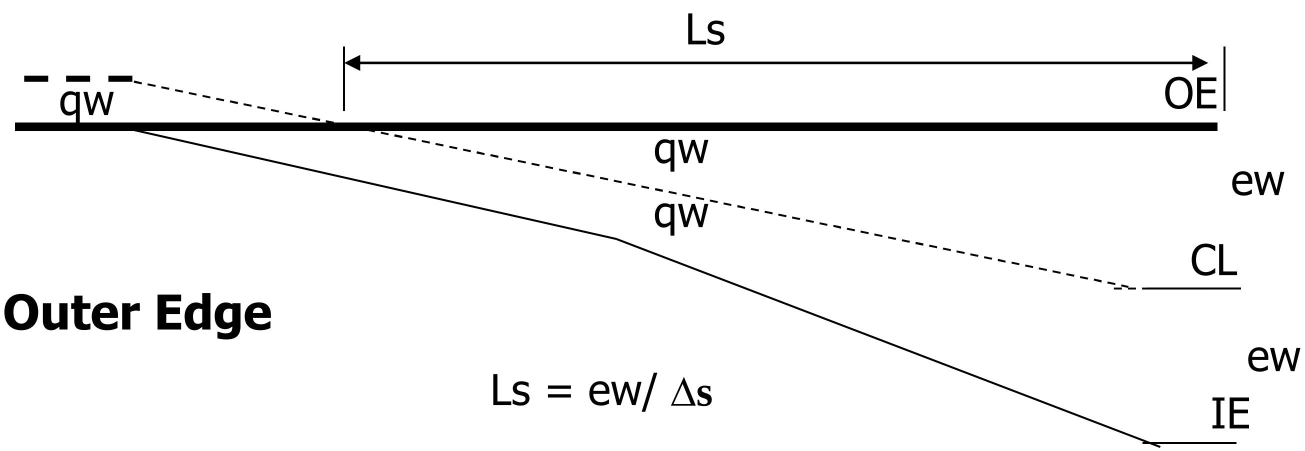


Superelevation Transition for 2way/2lane

Revolving about Inner Edge



Revolving about Outer Edge



Superelevation Transition for Divided HWY

- Revolving about the median centerline, median width < 4.5m.
- Revolving about the median edges, median width 4.5 - 12m.
- Revolving as a separate pavement , median width > 12m.

Design speed, kph	Max. relative gradient Δs between pavement edge and centerline
30	0.75
50	0.67
65	0.58
80	0.50
100	0.45
105	0.41
115	0.40

Δs between profile of the edge of 2-lane pavement are double those in table

Superelevation Transition for HWY

Pavement	Factor of Corresponding length for 2way/2lane
2 – lane	1.0
3 – lane	1.2
4 – lane	1.5
6 – lane	2.0

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Superelevation Runoff (L_T)

from AASHTO’2004

السرعة التصميمية (كم/ساعة)												الرفع الجانبي
20	30	40	50	60	70	80	90	100	110	120	130	
0	0	0	0	0	0	0	0	0	0	0	0	1.5
9	10	10	11	12	13	14	15	16	18	19	21	2.0
10	11	11	12	13	14	16	17	18	19	21	23	2.2
11	12	12	13	14	16	17	18	20	21	23	25	2.4
12	12	13	14	16	17	19	20	21	23	25	27	2.6
13	13	14	16	17	18	20	21	23	25	27	29	2.8
14	14	15	17	18	20	22	23	25	26	28	31	3.0
14	15	16	18	19	21	23	25	26	28	30	33	3.2
15	16	17	19	20	22	24	26	28	30	32	35	3.4
16	17	19	20	22	24	26	28	29	32	34	37	3.6
17	18	20	21	23	25	27	29	31	33	36	39	3.8
18	19	21	22	24	26	29	31	33	35	38	41	4.0
19	20	22	23	25	27	30	32	34	37	40	43	4.2
20	21	23	24	26	29	32	34	36	39	42	45	4.4
21	22	24	25	28	30	33	35	38	40	44	47	4.6
22	23	25	27	29	31	35	37	39	42	45	49	4.8
23	24	26	28	30	33	36	38	41	44	47	51	5.0
23	25	27	29	31	34	37	40	43	46	49	53	5.2
24	26	28	30	32	35	39	41	44	47	51	56	5.4
25	27	29	31	34	37	40	43	46	49	53	58	5.6
26	28	30	32	35	38	42	44	47	51	55	60	5.8
27	29	31	33	36	39	43	46	49	53	57	62	6.0

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Superelevation Runoff (L_T)

from AASHTO'2004

السرعة التصميمية (كم/ساعة)												الرفع الجانبي
20	30	40	50	60	70	80	90	100	110	120	130	
28	30	32	34	37	41	45	47	51	54	59	64	6.2
29	31	33	35	38	42	46	49	52	56	61	66	6.4
30	32	34	37	40	43	48	51	54	58	63	68	6.6
31	33	35	38	41	45	49	52	56	60	64	70	6.8
31	34	36	39	42	46	50	54	57	61	66	72	7.0
32	35	37	40	43	47	52	55	59	63	68	74	7.2
33	36	38	41	44	48	53	57	61	65	70	76	7.4
34	36	39	42	46	50	55	58	62	67	72	78	7.6
35	37	40	43	47	51	56	60	64	68	74	80	7.8
36	38	41	44	48	52	58	61	65	70	76	82	8.0
37	39	42	45	49	54	59	63	67	72	78	84	8.2
38	40	43	47	50	55	60	64	69	74	80	86	8.4
39	41	44	48	52	56	62	66	70	76	81	88	8.6
40	42	45	49	53	58	63	67	72	77	83	91	8.8
40	43	46	50	54	59	65	69	74	79	85	93	9
41	44	47	51	55	60	66	70	75	81	87	95	9.2
42	45	48	52	56	62	68	72	77	83	89	97	9.4
43	46	49	53	58	63	69	74	79	84	91	99	9.6
44	47	50	54	59	64	71	75	80	86	93	101	9.8
45	48	51	55	60	65	72	77	82	88	95	103	10

Superelevation Runoff (L_T)

from AASHTO'2004

السرعة التصميمية (كم/ساعة)												الرفع الجانبي
20	30	40	50	60	70	80	90	100	110	120	130	
46	49	52	56	61	67	73	78	83	90	97	105	10.2
47	50	53	58	62	68	75	80	85	91	99	107	10.4
48	51	55	59	64	69	76	81	87	93	100	109	10.6
49	52	56	60	65	71	78	83	88	95	102	111	10.8
50	53	57	61	66	72	79	84	90	97	104	113	11.0
50	54	58	62	67	73	81	86	92	98	106	115	11.2
51	55	59	63	68	75	82	87	93	100	108	117	11.4
52	56	60	64	70	76	84	89	95	102	110	119	11.6
53	57	61	65	71	77	85	90	97	104	112	121	11.8
54	58	62	66	72	79	86	92	98	105	114	123	12.0

Extra Width for Curves (Pavement Widening)

Two lane pavement widening varies from 0 to 2 m, maximum values in the range of 0.6 to 1.20 m are the most widely used. Values recommended are calculated from a formula,

$$W = L^2/2R + 0.1V/\sqrt{R}$$

where:

W = widening for 2-lane pavement on curve, m

L = wheel base; 6 m for SUT

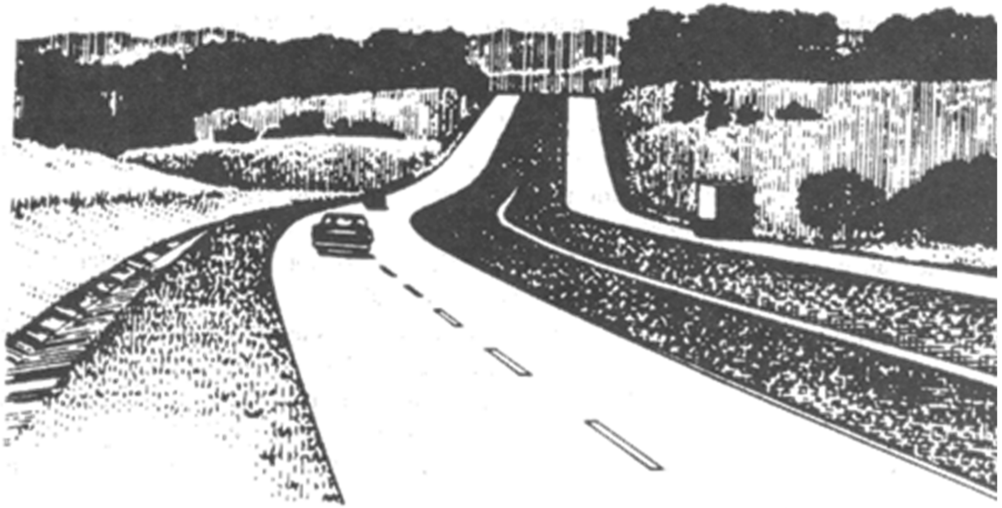
R = radius on centerline of 2-lane pavement curve, m

V = design speed; kph

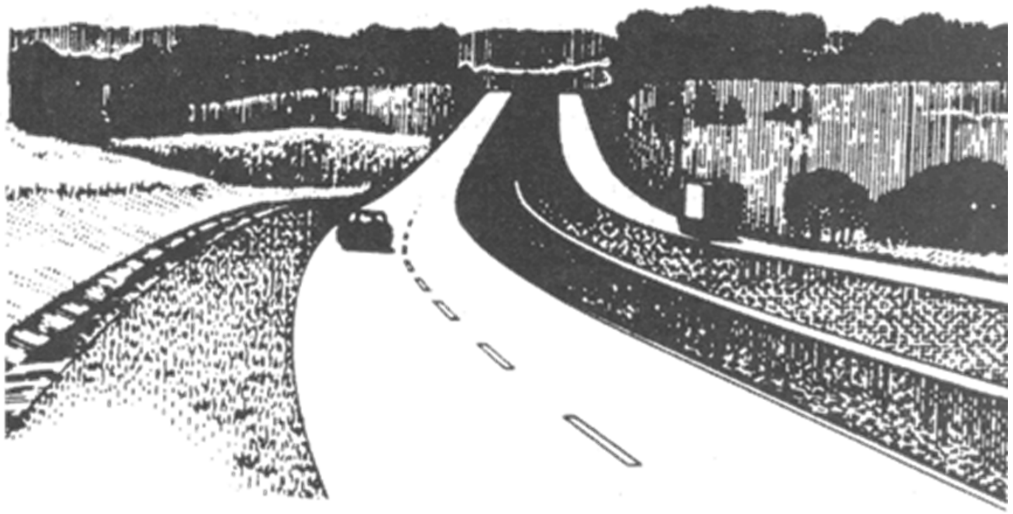
No Spiral

Spiral

Spiral Curves



No Spiral



Spiral

from AASHTO's *2001*

Spiral Curves

- SPECS no longer uses spiral curves
- Spiral Involves complex geometry
- Require more surveying
- If used, superelevation transition should occur entirely within spiral

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Spiral Curve

Is desirable especially with high speed and sharp curvature.

The minimum length of spiral curve (L_s) is given by the following equation:

$$\mathbf{L_s = V^3 / 28\,R}\text{ , or}$$

$$\mathbf{L_s = A^2 / R}$$

Where : L_s = length of spiral curve (m),

V = vehicle speed (kph),

A = Spiral parameter (m),

R = Radius of the circular curve (m).

V(kph)	40	60	80	100	120	140
A (m)	50	100	150	200	350	500

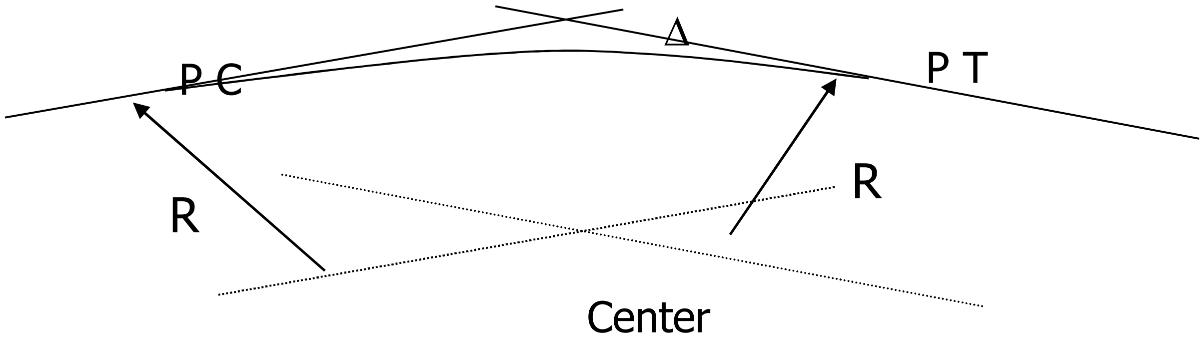
Desirable Spiral Lengths

Speed (km/hr)	Spiral Length (m)
20	11
30	17
40	22
50	28
60	33
70	39
80	44
90	50
100	56
110	61
120	67
130	72

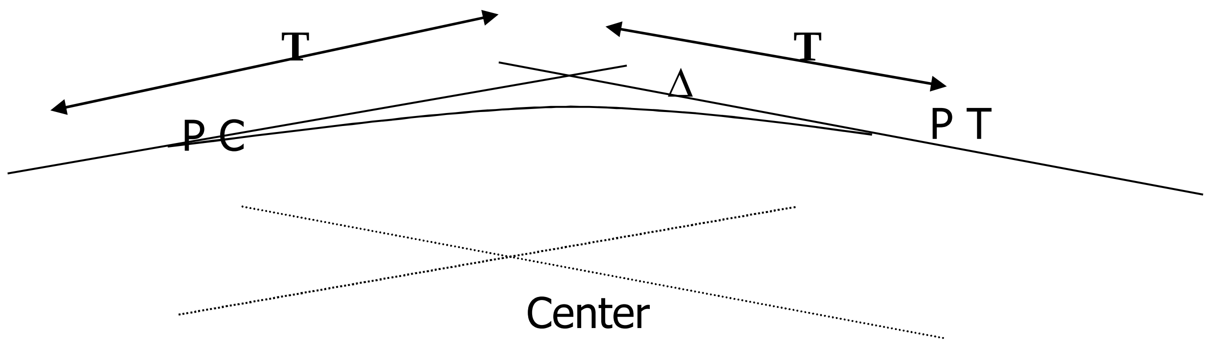
from AASHTO's *2001*

How to plot a simple curve?

Using R, Δ

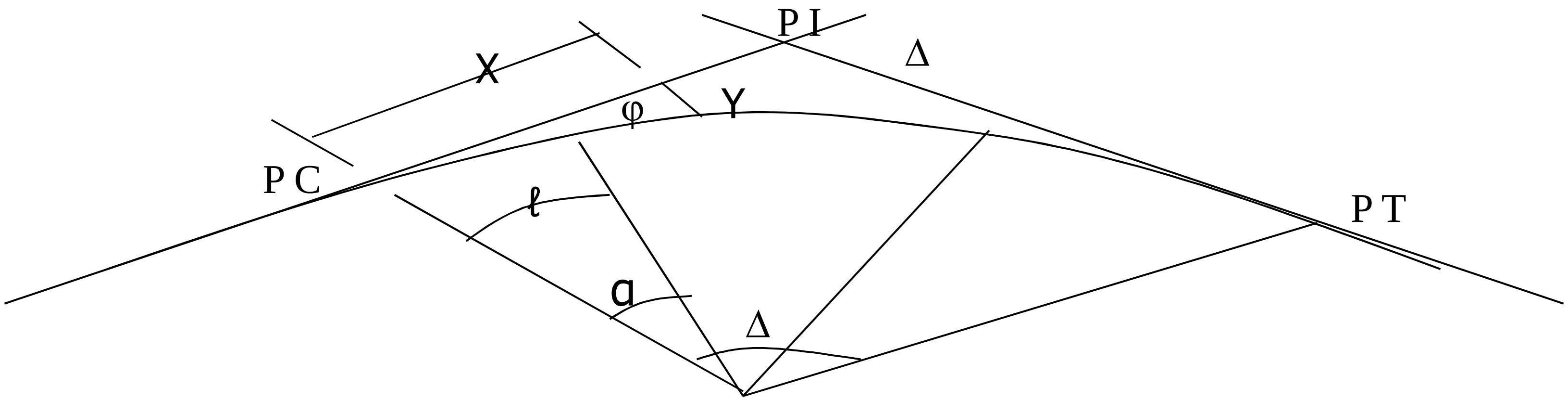


Using T, Δ



T = R tan **Δ / 2**

Setting out of a simple curve



For length on the curve = ℓ

$\alpha = (\ell \times D)/ 30.5$

$X = R \sin \alpha$

$Y = R (1- \cos \alpha)$

$\Phi = \alpha / 2$

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Example

Simple curve: R = 350 $\Delta = 40$ St. of PC = 25+00 Using ℓ = 25 m

	Station	Distance on curve ℓ	α	X	Y
PC	2372.6	0	0	0	0
	2375	2.5	0.409	2.5	0.009
	2400	27.5	4.508	27.51	1.083
	--	--	--	--	--
	--	--	--	--	--
PT	2616.6	244	40	224.9	81.88

$T = R \tan \Delta/2 = 350 \tan 20 = 127.4$

$D^{o} = 1750 / R = 1750 / 350 = 5$

$Lc = 30.50\ \Delta / D^{o} = 30.5 \times 40 / 5 = 244$

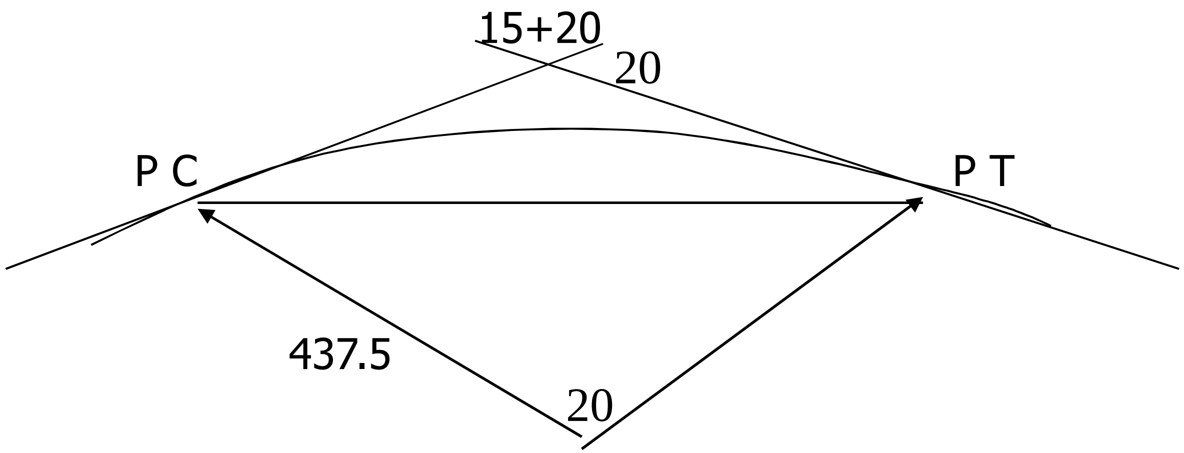
$\alpha = (\ell \times D) / 30.5$

$X = R \sin \alpha$

$Y = R (1 - \cos \alpha)$

Example

Determine the station of PC and PT of a simple horizontal curve with two tangents with 20^o deflecting angle and intersected at station (15 + 20). The degree of curve is 4.



Example

A corner of an existing building is 11.8 m from the centerline of a 12^{o} curved portion of a 2-lane highway having a lane width of 3.60 m. calculate the safe operating speed on that section.

Example

What is the minimum degree of curve that may be designed to provide for safe operation of vehicle of speed 100 kph. Take fs = 0.10 and e = 0.06. Will this provide for adequate sight distance if there is a corner of a building 10.00 m from the edge of the shoulder (lane width is 3.75 m and the shoulder width is 1 m).

Example

A horizontal curve of a 2-lane highway is built in a cut section as shown in the figure. Determine the maximum operation speed that would allow a safe operation on this curve given that R = 305 m.